6.5 ADVANCES IN HIGHER RESOLUTION GLOBAL OCEAN OBSERVING SYSTEM: SEA SURFACE WIND SPEED PERSPECTIVE

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ABSTRACT

In this paper we make an attempt to assess the performance of the Global Observing System in terms of global data sampling rate, taking the sea surface wind speed (SSWS) as an example. From the observational point of view, we attempt to address the question "What is the highest reasonable resolution of globally gridded products that can be produced from the existing global observing systems?" To this end, we computed the statistics of spatiotemporal sampling over the global ocean from the US satellite constellation that observes sea surface wind speed to show their evolution in time. We found that data sampling rates for global 0.25º bins have evolved from less than one per day to more than 6 per day from late 1987 to present. The distribution of the sampling time is relatively uniform over the day for the later years. Hence globally gridded products on a 0.25º grid are possible for increasingly higher temporal resolutions over this time period, from daily to twice daily and 6 hourly. Using a simple spatial-temporally weighted interpolation, 12-hourly sea surface wind speed fields were produced on a global 0.25º grid for this time period. Higher resolution (e.g. 6-hourly) products can also be produced with significantly reduced sampling aliases for the later years.

1. INTRODUCTION

The need for higher resolution and more accurate global air-sea fluxes (momentum, heat, water, CO2, etc.) have been articulated by several international working groups and modeling studies (e.g., WCRP Report No. 115; Large et al., 1991, Curry et al. 2004). In this presentation we look at the possibility of producing high resolution gridded global products based on the existing global observing systems using sea surface wind speed (SSWS) as a case study. Understanding this problem may also guide the design of future global ocean observing systems.

Long term SSWS observing satellites ranged from one Defense Meteorological Satellite Program (DMSP) satellite (F08) in mid 1987 to the present six satellites, as shown in Figure 1. Short lived satellites (e.g., NSCAT, SeaWinds on ADEOS I & II), non-US satellites (e.g., ERS-1/2), and satellites from which SSWS can also be retrieved along with sea level (e.g., altimetry satellites TOPEX/POSEIDON and Jason), are not shown and not used in this study. The passive DMSP observations are from the microwave radiometers on the Special Sensor Microwave/Imager (SSM/I; Hollinger et al., 1987; Wentz 1997). Among the latest additions to the passive microwave observations were the Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI; Kummerow et al. 1998) and the Advanced Microwave Scanning Radiometer - EOS (AMSR-E; e.g., Wentz et al. 1999). The active scatterometer (e.g., QuikSCAT) uses microwave radar and provides not only wind speed but also wind direction (e.g., Dunbar et al. 1991; Liu et al. 1998).

In the following we show the evolution of the global data coverage from the long term wind speed satellites shown in Figure 1. The individual satellite data were obtained from the 0.25ºx0.25º global grid data of the Remote Sensing Systems (RSS), Inc. (Wentz, 1997). In high latitude regions and where the first and last orbits of the day intersect, the most recent data replace earlier data in these RSS datasets. Using these datasets we explore the possibility of producing blended and gridded global products on a 0.25º grid for various temporal resolutions.

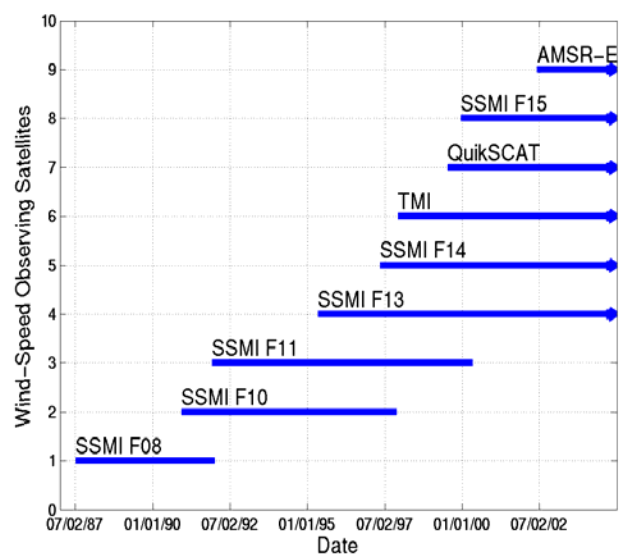

Figure 1. The long-term U.S. primary sea surface wind speed (SSWS) observing satellites over time. These satellites are used to derive the sampling statistics in this paper.

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2. COMPOSITE GLOBAL SAMPLING RATES – CASE STUDIES

To derive the summary plots of section 3, here we show some examples of the multiple satellite data sampling over the global ocean.

Figures 2a and 2b show the daily (in GMT) satellite sampling in the 0.25º grid boxes along several latitude circles for 1 January 2003. Note that near the polar regions, the number of satellite passes might be under-counted due to the data replacement within a day in the RSS datasets. Plotted in Figure 2a are the satellite sampling (passing) times (in GMT hours) within a day along the five latitude circles of 60ºS, 30ºS, 0º, 30ºN and 50ºN. Note that the longitude bins are 0.25º. Plotted in Figure 2b are the total numbers of satellite passes/samplings corresponding to the above five latitude circles and in the 0.25º boxes. On this date there were six satellites measuring the SSWS (DMSP F13, F14, F15, TMI, QSCAT, and AMSR-E). Even at the equator, the 0.25º bins were sampled on average at 6.7 times a day. The 0.25º-wide latitude circles at 30ºN/S were sampled about 9 times a day, partially due to the equatorial orbit of the TMI. Higher latitudes were sampled more than 9 times a day. The time intervals between samplings are less than 5 hours on average for all the latitudes.

In the earlier time periods the ocean was sampled less frequently. Before and in the early 1990s, only one satellite (F08) was available (Figure 1). Within one day and near the equator, the ascending and descending tracks overlapped only very rarely. On average the equator was only sampled about once per day. Moving poleward the number of samplings increased due the more frequently close-in and overlaps of the polar-orbiting ascending and descending satellite tracks.

3. SUMMARY

Over the passing years the ocean has been sampled in more detail as shown here. Figure 3 summarizes the averaged numbers of samples in the 0.25º bins over the global ocean. The mid and higher latitudes were sampled 4 or more times a day starting around mid 1997 and more than 6 times per day since beginning of 2000. The equatorial region was the least sampled, but since the beginning of 1998 it was also sampled at least 4 times a day and more than 6 times a day since mid 2002.

Corresponding to Figure 3, in Figure 4 we show the weekly averaged time intervals between successive samplings for each of the five latitude bands. It clearly shows that 6-hourly products have been practical since late 1997.

Given the above statistics, we have produced 12-hourly blended sea surface wind speed products using a simple spatial-temporally weighted interpolation for the time period July 1987 - present. Time alias is more problematic for the early years (before mid 1990s) than the later years. Daily, monthly and climatological monthly (1995-2004) datasets were also produced from the 12-hourly products. Six-hourly and an improved version using an optimum interpolation scheme is in progress. Details on these products can be found at a poster presentation (paper# P2.23) of this meeting and at the anonymous ftp site ftp://eclipse.ncdc.noaa.gov/pub/seawinds/ as well as an OpenDAP/DODS data server http://eclipse.ncdc.noaa.gov:9090/thredds/dodsC/oceanwind/catalog.html.

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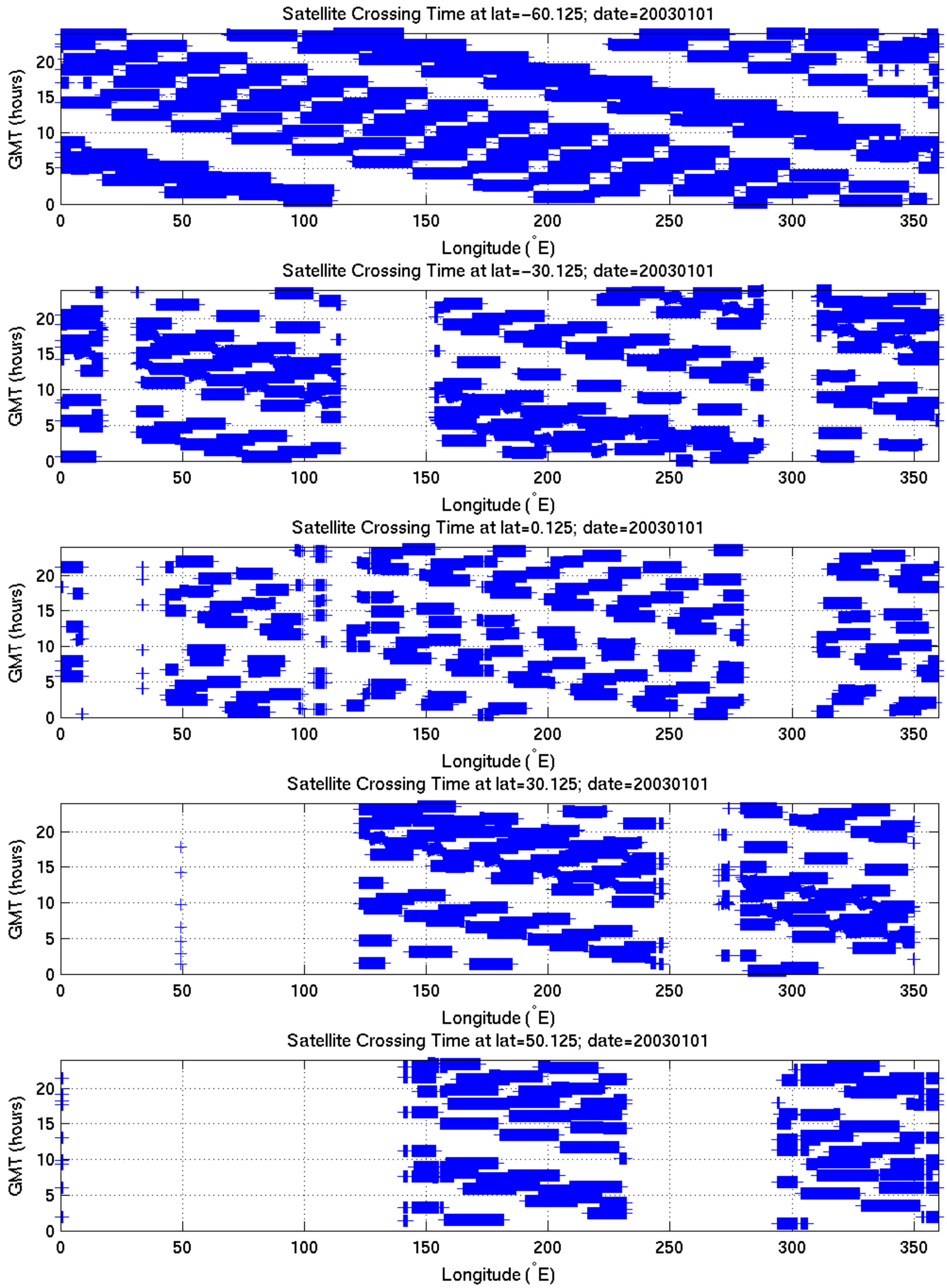

Figure 2a: Satellite passing times along 5 latitude circles for 1 January 2003. Data bin grids are 0.25º in space.

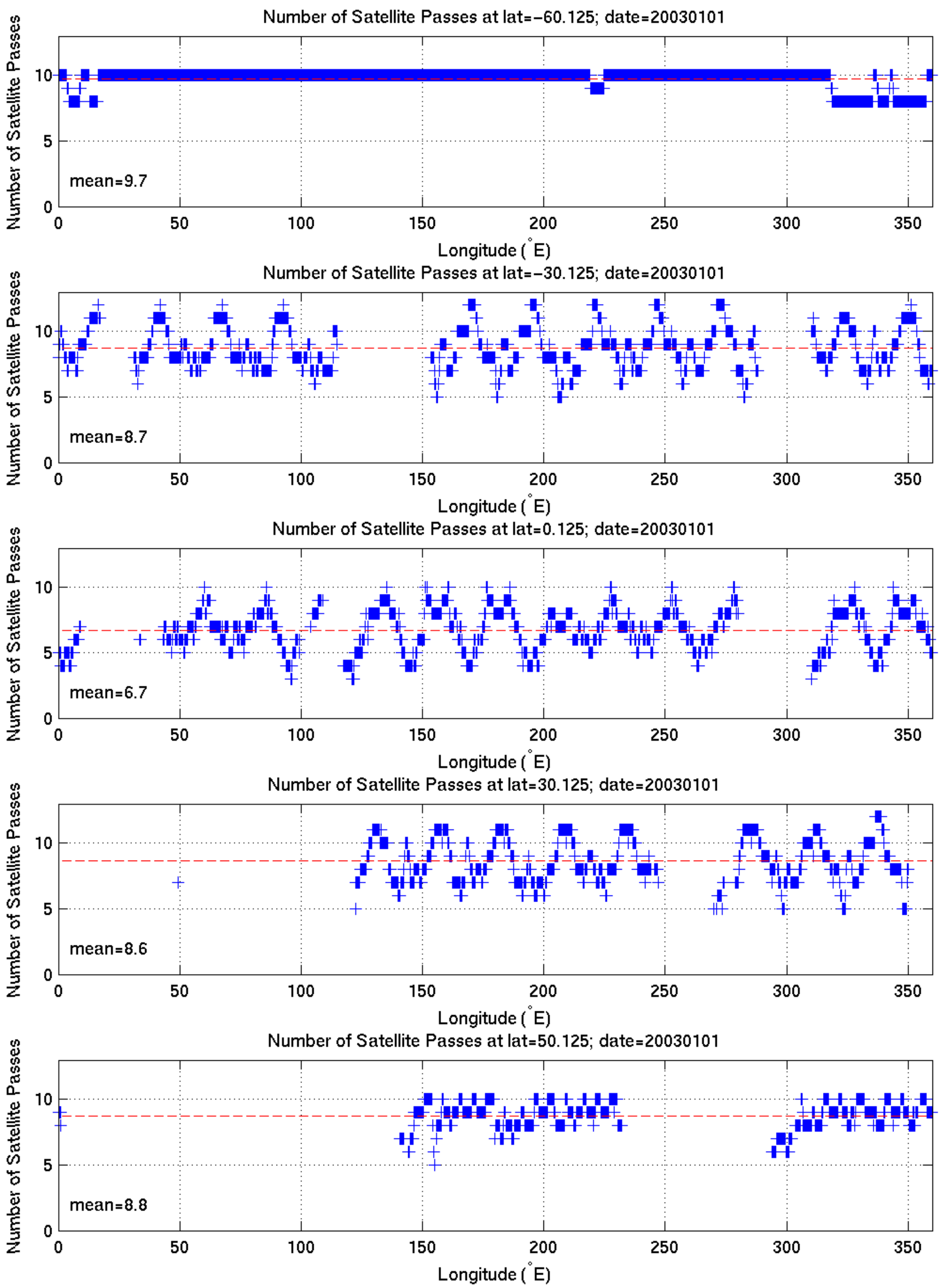

Figure 2b: Number of satellite passes along 5 latitude circles for 1 January 2003. Data bin grids are 0.25º in space.

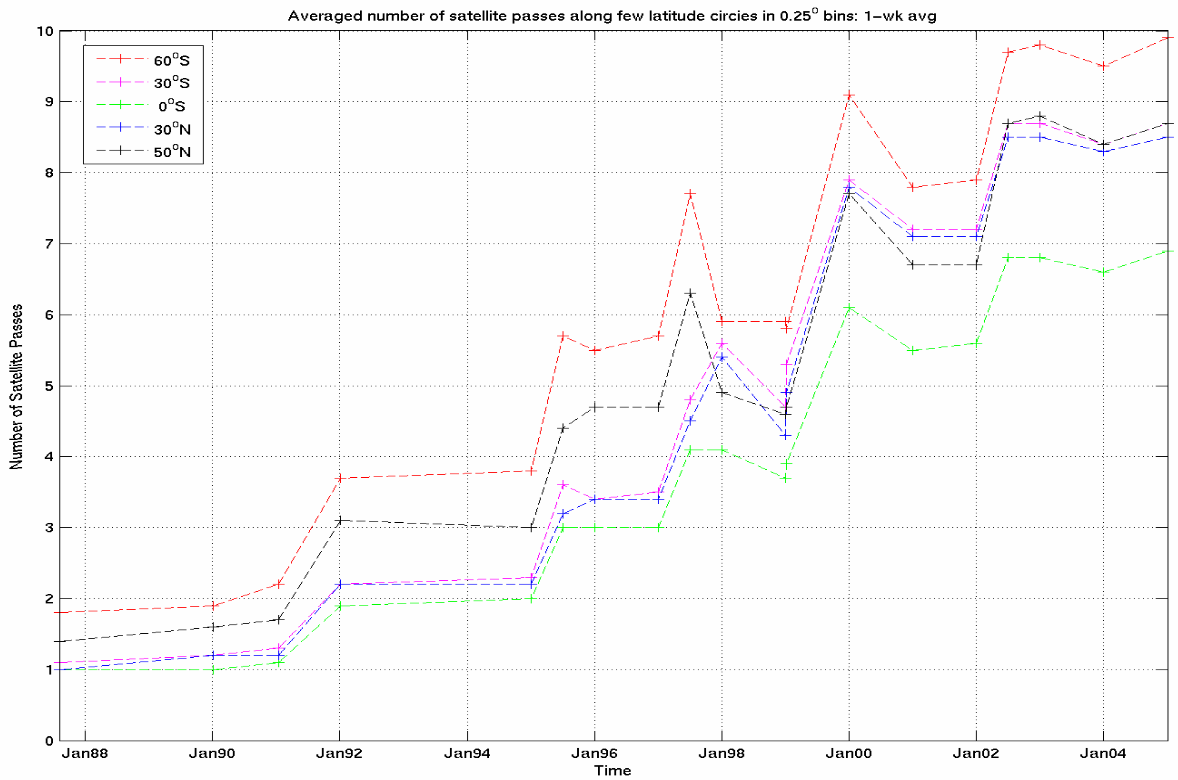

Figure 3: Averaged number of samplings over the 0.25º bins along the 5 latitude circles. Shown are 1-week averages.

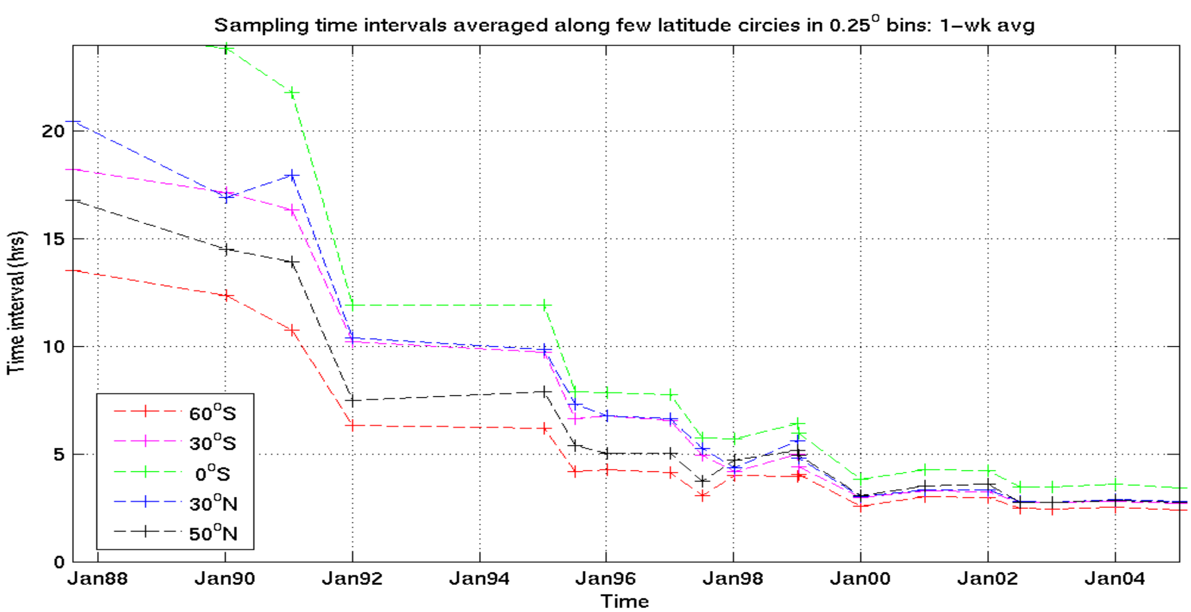

Figure 4: Sampling time intervals in the 0.25º bins. Shown are zonal averages along 5 latitude circles and averaged over 1 week.